

PROCESS FOR PRODUCING CYCLIC COMPOUNDS

RELATED PATENT DATA

This patent resulted from a divisional of U.S. patent application Ser. No. 12/702,818 filed on Feb. 9, 2010, now U.S. Pat. No. 7,973,177, which will issue Jul. 5, 2011, which is a divisional application of U.S. patent application Ser. No. 11/688,022 filed on Mar. 19, 2007, now issued as a U.S. Pat. No. 7,674,916, and which is a divisional of U.S. patent application Ser. No. 10/731,108 filed Dec. 10, 2003, now issued as U.S. Pat. No. 7,199,250, which claims benefit of priority under 35 U.S.C. §119 to U.S. Provisional Patent Ser. No. 60/435,469, which was filed Dec. 20, 2002, all of which are incorporated herein by reference.

TECHNICAL FIELD

The invention pertains to methods of processing di-carbonyl compounds, methods of producing cyclic compounds comprising a heteroatom ring member, including N-alkyl succinimide, and methods of producing pyrrolidinones.

BACKGROUND OF THE INVENTION

Cyclic compounds such as pyrrolidinones, N-substituted pyrrolidinones, other cyclic amines, and other cyclic compounds having one or more hetero-atom ring members, are useful as solvents, anti-fungal agents, pesticides, herbicides, anticorrosion agents, antioxidants, UV protectants, for use in forming polymers and plastics, and as reagents for forming other useful compounds. Conventional methods of forming these compounds can be expensive and inefficient. It would be desirable to develop processes for production of cyclic amines and other cyclic compounds.

SUMMARY OF THE INVENTION

In one aspect the invention encompasses a method of processing an initial di-carbonyl compound. The initial compound is converted to a cyclic compound having a ring nitrogen atom and two carbonyl groups. The cyclic compound is reacted with an alkylating agent to form a derivative having an alkylated ring nitrogen. The alkylated cyclic compound is produced in a mixture containing additional components and a purification process is performed to remove at least some of the additional components.

In one aspect the invention encompasses a method of producing an N-alkyl product. An initial solution is provided to a reactor, the initial solution comprises a di-carboxylate compound and ammonia, where the ratio of ammonia to the di-carboxylate compound is from 0:1 to greater than 2:1. For purposes of the description, when referring to a solution or mixture the term ammonia is intended to encompass either or both NH_3 and NH_4^+ , unless specifically indicated otherwise. The amount of ammonia in solution is adjusted to produce a solution having a second ratio of ammonia to di-carboxylate compound of from about 1:1 to about 1.5:1. An alkylating agent is added to the solution having the second ratio and the initial compound is alkylated and cyclized to produce a cyclic N-alkyl product.

In one aspect the invention encompasses a method of making N-methyl pyrrolidinone. An aqueous mixture comprising ammonia and succinate is introduced into a vessel. The amount of ammonia in the aqueous mixture is adjusted to provide a ratio of ammonia to succinate of from about 1:1 to less than about 2:1. A methylating agent is introduced into the vessel and is reacted with succinate at a temperature of from greater than 100° C. to about 400° C. to produce N-methyl

succinimide. The N-methyl succinimide is at least partially purified and is subsequently hydrogenated to form a product mixture comprising N-methyl pyrrolidinone.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention are described below with reference to the following accompanying drawings.

FIG. 1 is a block-diagram flowchart view of a generalized method encompassed by the present invention.

FIG. 2 is a process flow diagram showing a processing system that can be used in performing particular aspects of the present invention.

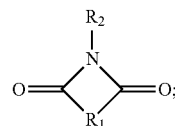
FIG. 3 is an illustration of potential equilibrium reactions that can occur in a particular aspect of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This disclosure of the invention is submitted in furtherance of the constitutional purposes of the U.S. Patent Laws "to promote the progress of science and useful arts" (Article 1, Section 8).

In general, methods according to the present invention can be utilized to produce a cyclic nitrogen-comprising compound having formula (I),

Formula (I):



where R_1 is a linear or branched, saturated or unsaturated hydrocarbon or substituted hydrocarbon. Preferably, R_1 contains twenty or fewer non-hydrogen atoms, and in particular instances can preferably comprise from 1-10 carbon atoms. Alternatively, R_1 can be absent such that the resulting product is a three membered nitrogen comprising ring compound. R_2 can be an alkyl (linear, cyclic or branched, saturated or unsaturated), a substituted alkyl group, an aromatic group or hydrogen.

R_1 can preferably be a branched or un-branched, saturated or unsaturated, substituted or non-substituted group which allows the ring structure of formula (I) to be a 5-, 6- or 7-membered ring. In particular instances, the formula (I) compound can have one of the 5- or 6-membered ring formulas shown in Table 1, where R_3 through R_8 are not limited to any particular groups, and can be independently selected from hydrogen, hydroxyl, hetero-atom comprising functional groups, linear or branched groups, and saturated or unsaturated groups, including hydrocarbon groups or substituted hydrocarbons.

TABLE 1

Example Formula (I) Compounds	
5-member ring compounds	6-member ring compounds